REMARKS

In the response to the Official Action mailed June 18, 2003, Applicant amends his application and requests reconsideration. No claims are added or cancelled so that claims 1, 4-7, and 10 remain pending.

Claims 1, 5, and 6 were objected to. The objection is based upon an inadvertent error made in the previous amendment. That error is corrected here by identifying in claim 1, as intended, the *first* bonding pad and eliminating reference to a *first* conductive layer. This minor amendment of an inadvertently misplaced word overcomes the claim objection.

In addition to the correction made to claim 1 in response to the claim objection, claim 1 is clarified in this amendment. The term "second contact" may have had an uncertain meaning and have led to confusion in interpreting the claim. In amended claim 1, the second contact is more clearly identified and relates to the electrical interconnection between the bonding wire and the first bonding pad. The second contact includes at least two layers of the bonding wire.

Claim 7 is also amended for clarity in this Amendment. It is believed that claim 7 as examined was clear and that the language added to claim 7 here is merely surplusage that is not essential to understanding the claim. However, in view of the nature of the rejection made in the Official Action, claim 7 is amended so that the apparent confusion in construing the claim will not continue.

The claims pending in this patent application and under examination fall under two groups. Claim 1 and its dependent claims 4-6 are directed to a semiconductor device that includes a wire bonding structure as described in claim 1. Claim 4 describes an additional element connected to a conductive layer and claims 5 and 6 are directed to a resin encapsulated semiconductor device incorporating the invention as described in claim 1. Thus, if claim 1 is patentable over the prior art, so are claims 4-6. For that reason, attention here is directed to the rejection based upon independent claim 1 without separate discussion regarding claims 4-6.

The second group of claims includes independent claim 7 and its dependent claim 10. Again, attention here is focused on independent claim 7. If that method claim is patentable over the prior art applied in the rejection, so is claim 10.

Figures 4 and 6 of the patent application illustrate, through demonstration of the process of making, a contact structure that is within the scope of claim 1. Attention is directed to the final paragraph of that claim 1 which describes a double layer, i.e., two layers,

of the bonding wire, element 1 of Figures 4 and 6, that lie directly on each other. Because these two layers are part of the same bonding wire, the bonding wire has to include at least one reverse bend. In the claimed structure, a first of those two layers of the bonding wire is in contact with the first bonding pad. It is apparent that the first of the at least two layers of the bonding wire is in contact with the first layer of the bonding wire because of the very words of the final paragraph of claim 1. The bonding structure shown in Figures 4 and 6 actually includes three such layers of the bonding wire, a first of the layers in contact with and joined to the first bonding pad and the other two layers of the bonding wire being sequentially disposed on each other and the first layer. In the depicted embodiments, there are two reverse bends, i.e., hairpin bends, as described in the patent application. The structure claimed includes a ball bond, element 2 in the depicted embodiments, bonded to a conductive layer, element 10 in the figures. The wire 1 in the figures extends from that ball bond to the first bonding pad including the second contact having the multiple layer arrangement of the wire on the first bonding pad.

Claim 1, and its dependent claim 4, was again rejected as unpatentable over the prior art described in the patent application (APA) in view of Ono[1] (JP 8-186117). This rejection is respectfully traversed again.

The rejection is respectfully traversed because the Examiner has not demonstrated that the prior art includes all of the limitations of claim 1. The failure of the rejection becomes readily apparent when the language of the Official Action, allegedly citing the language of the examined claim, is compared to the language of that claim. As explained above, that language has now been modified for clarity. Since there is a strong likelihood that, if the claims are not allowed, there will be an Appeal, the Examiner may wish to revise the Official Action to clarify his position with regard to the language of the amended claim 1 for the assistance of the Board of Appeals.

In making the two rejections citing Ono, the Examiner did not indicate that he had consulted any publication other than the Japanese language version of Ono, all that was supplied in the Official Action mailed February 28, 2003. For the Examiner's assistance, an English language abstract of that publication, as well as a machine-generated translation of Ono, from the JPO website, are attached. As often happens with these computer-generated translations, there is some particularly odd language, in this case pertaining to the ball 9 that is formed in the ball bonding process illustrated in Figures 3(a)-3(f) of Ono, figures relied upon by the Examiner in rejecting the claims.

[1] Applicant continues to prefer to use the family name of the first inventor named in JP 8-186117, rather than the inventors' given name.

In explaining the rejection at the final four lines of page 2 of the Official Action and the first two lines of page 3, the language of examined claim 1 is allegedly reproduced. The reproduction is incomplete and is inaccurate, in part, with respect to examined claim 1.

Applicant agrees, referring to the language of amended claim 1, that Figure 8 of the patent application, a prior art figure, illustrates a conductive layer 10, a first contact including a ball 2 on the conductive layer 10, and a first bonding pad 6 spaced apart from the conductive layer 10. However, what the Examiner characterized as the second contact 9 in Figure 8 is actually a second ball on the first bonding pad 6. In examined claim 1, the second contact was defined as including two layers of the bonding wire. Thus, the comparison between the APA and the second contact of examined claim 1 was incorrect. The comparison is even more clearly incorrect with regard to amended claim 1.

At the first line of page 3 of the Official Action, the Examiner identified the bonding wire 1 which does connect the ball to what the Examiner erroneous characterized as the second contact 9. The second line of page 3 of the Official Action is not understood and omitted critical language of claim 1. According to that line of the Official Action, the second contact 9 of Figure 9 of the patent application, also designated as prior art, includes one layer of the bonding wire 1. If the second contact of that figure is the ball 9, the ball 9 does not include any part of the bonding wire, although the bonding wire 1 is attached to the ball 9. Rather, the ball 9 is a remnant of a different bonding. Moreover, what is described in the final paragraph of examined and amended claim 1 is that there are two layers of the bonding wire and that one of the layers is in contact with the first bonding pad. It is apparent by inspecting Figures 8 and 9 of the patent application that there is no contact between any part of the bonding wire 1 and the first bonding pad 6. There is also no reverse bend in the ball 9 or the wire 1.

There are no comments in the Official Action as to where the parts of claim 1 that are missing from the APA are not found in Ono. In fact, the missing parts of claim 1 are not found in Ono. The only parts of Ono that seem to be potentially pertinent to claim 1 relate to the process illustrated in Figures 3(a)-3(f) of Ono. Since the description in the Official Action of what appears in the APA lacks, essentially, any part of the final paragraph of claim 1, if the rejection is to be proper and maintained, the structure of the second contact must be found in Ono. However, that second contact structure is missing from Ono.

What appears in the cited figures of Ono is a process that includes forming a ball bond, subsequently bending the wire 4 extending from the ball to form one reverse bend 8 and what is characterized by Ono as a reverse L-shape part of the wire 4 as shown in Figure 3(d) of Ono. At that stage, there is no interconnection between the wire 4 and any element

other than the ball 9. Then, particularly as described in the translation supplied here, the wire bonding tool 1 is employed to sever the wire 4. Ono is not clear as to whether the reverse bend is retained after the severing of the wire 4. Even assuming the single reverse bend is present, it is apparent that in Figure 3(d) of Ono two layers of the bonding wire may be in direct contact with each other, but neither of those layers is in contact with the bonding pad 13 of Ono. Moreover, no suggestion can be found in Ono that the wire should be placed in contact with that bonding pad 13. Rather the wire 4 is severed, before reaching the pad 13. The remaining two layer wire stub is subsequently compressed by the bump 15 protruding from a surface of the wire bonding tool 1.

To make the error in the rejection readily apparent, neither the prior art described in the patent application nor Ono illustrates a bonding wire "in contact with said first bonding pad". Moreover, neither source of prior art suggests there should be such a contact, for example by removing the second ball 9 in the APA or providing some unusual interconnection of the bonding wire 4 in Ono. Since an important element of claim 1 is completely missing from the two sources of prior art applied in rejecting claim 1, *prima facie* obviousness has not been established and cannot be established based upon the prior art applied. This failure of the rejection is made particularly apparent by the failure of the Official Action even to assert that each of the elements of claim 1 can be found anywhere in the prior art. The rejection of claim 1 and of its dependent claims 4-6 is legally erroneous and cannot be properly maintained. Those claims should now be allowed.

Claims 5 and 6, which depend from claim 1, were further rejected as unpatentable over the APA as allegedly modified by Ono and further in view of Hikita et al. (U.S. Patent 6,133,637, hereinafter Hikita). Hikita was cited only with respect to an encapsulated semiconductor device, not with respect to the structure of the second contact of claim 1. Therefore, even if Hikita discloses the limitations of claims 5 and 6, a point not conceded, Hikita cannot, in combination with the APA and Ono, supply all of the limitations of claim 1. Thus, the rejection of claims 5 and 6 is traversed and further discussion is not required.

While the Official Action stated at page 2 that claims 9 and 10 were rejected on the same basis as claims 1 and 4, it is understood from pages 3 and 4 of the Official Action that the method claims 7 and 10 were rejected on that basis. This rejection is respectfully traversed.

In rejecting claims 7 and 10, the Official Action, at page 3, sets out with bullets a comparison of the language of claim 7 to Figures 8-11 of the patent application, APA figures. Applicant agrees that Figure 8 illustrates forming of a ball bond to a conductive layer 10. The second point in the Official Action describes joining of the bonding wire to a bonding

pad *via a second ball 9*. The italicized language of the Official Action appears nowhere in claim 7. In fact, the language of claim 7 is directly contrary to the language that the Examiner has apparently imported into claim 7. Claim 7, in the second paragraph, states that the first part of the bonding wire is joined *directly* to the bonding pad. There is no mention of any second ball and, in fact, the language of claim 7 excludes the presence of an intermediate element between the wire and the bonding pad, such as the ball 9 shown in Figure 8 of the patent application. This overt error in construing claim 7 is sufficient, alone, to demonstrate that *prima facie* obviousness has not been established with respect to claim 7. The primary source of prior art is simply different from what is described in the claim, as conceded by the Examiner. Applicant agrees that in Figure 11 the bonding wire 1 is deformed after the bonding wire is bonded to the ball 9. In fact, the deformation is so severe that the wire is intentionally ruptured. There is no description of folding of that wire in the APA, as acknowledged in the final paragraph at page 3 of the Official Action.

Apparently Ono is relied upon for all of the elements of claim 7 not described in the APA. However, Ono fails to supply all of those elements. For example, Figures 3(a)-3(f) of Ono do not show any bonding wire *directly* joined to a bonding pad. As already described, in the process illustrated in those figures, a reverse bend 8 is formed in a bonding wire 4 that is subsequently severed, with the free end of the bonding wire pressed against the ball 9. Thus, neither the APA nor Ono discloses the second step of claim 7, precluding *prima facie* obviousness of that claim founded upon those two sources of prior art.

The failure of the combination of the APA and Ono to meet the second step of claim 7 means that the combination fails to meet the third step of claim 7 which requires that, during the mechanical deforming, the first part of the bonding wire must remain joined to the bonding pad. The Examiner readily acknowledges the formation of intermediate ball 9 in both the APA and Ono, precluding the joining described in claim 7 and preventing *prima facie* obviousness of claim 7 with respect to the third step of that claim.

Further, with respect to that third step of claim 7, especially with regard to the clarified amended claim 7 presented here, it is apparent that the reverse bend 8 in Ono never provides that a first part of the bonding wire is located directly opposite the bonding pad and between the bonding pad and the second part of the bonding wire. This arrangement, already present in the form of claim 7 that has been examined, is even more clearly described in amended claim 7, providing an additional reason why *prima facie* obviousness of claim 7 has not and cannot be establish by any combination of the APA and Ono. Even the process referred to in the Official Action as "crowing", presumably meaning crowning, in which the bend of the bonding wire 4 in Ono is compressed, as illustrated in Figure 3(e) of Ono, does

not alter the orientation of the wire 4 with respect to the bonding pad 13 nor does it remove the interposition of the ball 9 between the bonding wire and the pad 13. Removal of the ball 9 would be essential to meet the limitations of claim 7.

The rejection of method claim 7, and therefore of its dependent claim 10, is erroneous because there are at least three differences between the claimed process and anything disclosed in either of the APA and Ono. *Prima facie* obviousness has not been established because of each and all of these differences. Therefore, upon reconsideration, the rejection should be withdrawn.

Since all claims now pending in this patent application are clearly patentable over the prior art relied, this claim should now be allowed.

Respectfully submitted,

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The Delphion Integrated View

Title: **JP8186117A2: METHOD FOR CAPILLARY AND BUMP FORMING OF WIRE**

Country: **JP** Japan
Kind: **A**

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News, Profiles, Stocks and More about this company

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Priority Number: Dec. 28, 1994 **JP1994000327955**

Abstract:

PURPOSE: To electrically connect the end of the bump of a semiconductor device to the terminal electrode of a circuit board with high reliability when the device is face-down-mounted on the terminal electrode of the board formed by screen printing, plating, etc., via a junction layer.

CONSTITUTION: A curvature 24 is formed at the end of the bump of a semiconductor device 6, and face-down-mounted at the input and output terminal electrode 28 of a circuit board 29 via a junction layer. Thus, the thickness of the junction layer can be formed thinnest and uniform, and the electric connection and adherence of the low connecting resistance of the connecting part and high reliability can be realized.

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Family: None

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* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the semiconductor unit using the formation method of the bump and bump who have a curve side for connecting electrically the terminal electrode of the circuit board and the electrode pad of a semiconductor chip by using the capillary for wirebonding equipments, and it, and its bump.
[0002]
[Description of the Prior Art] The capillary tube for the conventional wirebonding equipments is indicated by a bonding handbook, a capillary-catalog, etc. of a microphone loss chair company.
[0003] Drawing 10 (a) shows the point of the capillary tube for wirebonding equipments, and drawing 10 (b) shows the configuration of the point of a capillary tube more to the detail.
[0004] the wire derivation for the capillary tube 81 of a cylindrical shape inserting the metal wire for bondings in the interior, as shown in drawing 10 (a) -- it has the hole 82 wire derivation -- the size of a hole 82 is 25 micrometers phi-50 micrometerphi grade In consideration of the configuration and size of a metal wire after the interval which carries out bonding, and bonding, the angle alpha of about 30 degrees is given to the outside of the point of a capillary tube 81.
[0005] The configuration of the point of the capillary tube 81 in the case of using the metal wire about 25 micrometerphi is shown in drawing 10 (b). In this case, diameter:[of a hole]38micrometer, diameter:[of a chip]203micrometer, and the diameter of a chamfer: It is 74 micrometers. By using such a capillary tube 81, a bump can be formed on the electrode pad of a semiconductor device, or electric connection with the terminal electrode of other circuit boards can be made.
[0006] Next, the conventional method of forming the bump of a semiconductor device by the ball bonding method is explained using the capillary tube for wirebonding. The formation method of the electrical installation bump (henceforth a two-step bump) of a two-step protrusion configuration and the two-step bump using the conventional capillary tube is shown in JP,2-34949,A.
[0007] Drawing 11 (a) - (d) shows how to form a two-step bump by the conventional ball bonding method.

[0008] it is shown in drawing 11 (a) -- as -- wire derivation of a capillary tube 81 -- it lets the metal wire 84 of 25 micrometerphi pass to a hole 82 And the ball 85 which has an about 2 to 3 times as many diameter as the path of the metal wire 84 is formed at the nose of cam of the metal wire 84 by giving heat energy.
[0009] Next, the ball 85 formed at the nose of cam of the metal wire 84 is made to contact the electrode pad 183 of the IC chip 86 by dropping a capillary tube 81, as shown in drawing 11 (b). By giving the method and supersonic oscillation of thermocompression bonding, the electrode pad 183 is made to fix a ball 85, and a two-step bump's pars basilaris ossis occipitalis 89 is formed.
[0010] and it is shown in drawing 11 (c) -- as -- a two-step bump's pars basilaris ossis occipitalis 89, and wire derivation of a capillary tube 81 -- while it has been in the state with which the metal wire 84 which the hole 82 let pass was connected, a capillary tube 81 is moved in the shape of a loop to the IC chip 86 A capillary tube 81 cuts the metal wire 84, moving so that a loop-like orbit may be drawn and descending perpendicularly after that, after going up first at right angles to a two-step bump's pars-basilaris-ossis-occipitalis 89 upper part.
[0011] As shown in drawing 11 (d), on a pars basilaris ossis occipitalis 89, the metal wire 84 is formed of movement of the shape of a loop of a capillary tube 81 the shape of a ring, and inverted-L-shaped. This

portion forms a two-step bump's crowning 88. A two-step bump is formed by cutting the metal wire 84 by the edge portion 182 of a capillary tube 81.
[0012] The outline cross section of that (height was arranged) which leveled this two-step bump is shown in drawing 12 .
[0013] And the conventional example of the mounting method is described below. In case a semiconductor device is conventionally mounted in the input/output terminal electrode of the circuit board, the wirebonding method which used soldering is used well. However, by the miniaturization of the package of a semiconductor device, and the increase in the number of end-connection children, an end-connection child's interval becomes narrow and it is becoming difficult gradually to cope with it with the conventional soldering technology in recent years.
[0014] Then, recently, the method of a component-side product being miniaturized and aiming at efficient use has been proposed by mounting semiconductor devices, such as an integrated circuit chip, directly on the input/output terminal electrode of the circuit board.
[0015] Especially, suppose at the circuit board that it is a semiconductor device a method with the method useful from that electrical installation of a semiconductor device and the circuit board is made collectively, and the mechanical strength after connection being strong of carrying out flip chip mounting in the state of a face down.
[0016] For example, the mounting method which used the solder galvanizing method for the volume Kogyo Chosakai Publishing Co., Ltd., January 15, 1980 issue, and on Japanese microelectronics association and "IC-ized mounting technology" is indicated. This mounting method is explained below.
[0017] Drawing 13 shows the outline cross section (a) of the solder bump of the conventional semiconductor device, and the outline cross section (b) of a semiconductor unit. As shown in drawing 13 , when connecting the electrode pad 113 of a semiconductor device (IC substrate) 116 to the input/output terminal electrode 118 of the circuit board 119 shown in drawing (b), the adhesion metal membrane 112 and the diffusion prevention metal membrane 111 are first formed by the vacuum deposition on the electrode pad 113 of a semiconductor device (IC substrate) 116, and the electrical installation contact (henceforth a solder bump) 110 which consists of solder is further formed with plating on this. Next, as IC chip formed by doing in this way is shown in drawing 13 (b), alignment is performed in the state of a face down so that the solder bump 110 may contact on the input/output terminal electrode 118, and it lays on the circuit board 119. Then, the solder bump 110 is welded to the input/output terminal electrode 118 of the circuit board 119 by heating the mounting object (semiconductor unit) of this semiconductor device to an elevated temperature.
[0018] Moreover, recently, as shown in the outline cross section of the semiconductor unit which used the electroconductive glue of drawing 14 , the electrical installation contact (Au bump) 120 is formed with the wirebonding method or plating on the electrode pad 123 of a semiconductor device (IC substrate) 126, and a semiconductor unit which connects this Au bump 120 to the input/output terminal electrode 128 of the circuit board 129 through an electroconductive glue (junction layer) 125 is also proposed. In such a semiconductor unit, after imprinting an electroconductive glue 125 by the Au bump 120 of a semiconductor device 126, alignment was carried out so that the Au bump 120 might contact the input/output terminal electrode 128 of the circuit board 129, the electroconductive glue 125 was hardened, and electrical installation has been obtained.
[0019]
[Problem(s) to be Solved by the Invention] Above conventional capillary tubes, conventional bumps, and bump formation methods require cost, in order for a semiconductor device to take the process which forms a bump, and the leveling process for operating the bump who formed orthopedically further. Moreover, the equipment for performing leveling is also required separately. However, it is not desirable to skip a leveling process. Since a bump's crowning 88 in which it was formed by the ball bonding method is carrying out the shape of a ring, and the inverted-U character type configuration, and the area of the edge of a crowning 88 is small, its touch area with the terminal electrode of the circuit board is small. Moreover, since the variation in a bump's height is also large, reliable connection cannot be made in having mounted as it is. Furthermore, in the above configurations of the bump before leveling, when using an electroconductive glue for a junction layer, since the bond strength after carrying out electroconductive-glue hardening from there being few amounts of imprints of the electroconductive glue to a bump point,

and the variation in the amount of imprints being large is small, connection resistance will also become [the reliability of adhesion] low greatly.
[0020] Since the terminal electrode on the circuit board is formed by screen-stencil or plating, the cross-section configuration of a terminal electrode is curving to convex. Therefore, if the bump who prepared the convex or flat apical surface of a semiconductor device is connected to a terminal electrode through a junction layer, it will become small [electrical installation resistance] most [between the peak of the curve side of a terminal electrode and a bump's points]. Therefore, when a gap arises at the time of alignment, the distance of a terminal electrode separates with a bump and connection resistance increases. Moreover, a connection also becomes unstable.
[0021] The place which it is made in order that this invention may solve the above-mentioned technical problem, and is made into the purpose The capillary for wirebonding equipments which makes it possible for reliability to be good and to connect a semiconductor device and the circuit board stably electrically easily, It is in offering the semiconductor unit (mounting object) which has the formation method of the bump and bump who have a curve side for connecting electrically the terminal electrode of the circuit board and the electrode pad of a semiconductor chip using it, and its bump.
[0022]
[Means for Solving the Problem] The formation method of the bump by this invention is the method of forming the bump for connecting electrically the terminal electrode of the front face of the circuit board, and the electrode pad of the semiconductor device mounted in the state of a face down on the front face of the aforementioned circuit board, and is characterized by to include the process a which forms the aforementioned bump on the electrode pad of the aforementioned semiconductor device, and the process b which forms a curve side in the aforementioned bump's point.
[0023] The circuit board to which the semiconductor unit by this invention has a terminal electrode on a front face, It is the semiconductor unit which has the semiconductor device mounted in the state of the face down on the front face of the aforementioned circuit board. the aforementioned semiconductor device It is characterized by having a bump for connecting electrically an electrode pad, the aforementioned electrode pad, and the aforementioned terminal electrode, forming a curve side in the aforementioned bump's point, and forming the junction layer between the aforementioned bump's point, and the aforementioned terminal electrode.
[0024]
[Function] In order that a bump's curve side may connect with the curved surface of a terminal electrode by forming a concave-like curve side in a bump's point in a field, the connection distance of a bump and a terminal electrode will be shortened and the electric flow of this invention improves. Moreover, since bulk is formed stably, a bond strength is reinforced and reliability improves extremely.
[0025]
[Example] Below, each example of this invention is explained based on a drawing.
[0026] (Example 1) Drawing 1 (a) is the outline cross section of the point of the capillary tube for wirebonding in the 1st example of this invention. Drawing 1 (b) shows the configuration of the point of a capillary tube more to the detail.
[0027] leveling with which the capillary tube 1 of a cylindrical shape was formed in the periphery section of the point as shown in drawing 1 (a) -- it has the lobe 3 which is a member The capillary tube 1 is made with the ceramic or the artificial ruby. The soffit side (leveling side) 15 of a lobe 3 has a convex type-like curve side, and it is established so that the height from the face 11 at the nose of cam of a capillary tube 1 may be the predetermined value d. The size of the soffit side 15 can be set up according to the size of a bonding pitch and a bump's diameter of a nose of cam which should be fabricated. Moreover, in consideration of the configuration and size of a metal wire (or bump) after the interval which carries out bonding of the outside of the point of a capillary tube 1, and bonding, the angle alpha of about 10-30 degrees is given.
[0028] As shown in drawing 1 (b), when using the metal wire about 25 micrometerphi, the configurations of the point of a capillary tube are diameter:of hole38micrometer, diameter:of chip203micrometer, and diameter:of chamfer74micrometer.
[0029] Drawing 2 is the front view of the bump of the semiconductor device in the 1st example of this invention, and this shows one of two or more electrical installation points that it can set to some

semiconductor devices. As shown in drawing 2 , the salient electrode (henceforth a bump) 27 is formed on the semiconductor device (henceforth IC substrate) 6. The concave-like curve side 24 is established in this bump's 27 point. In this example, the bump 27 has 2nd bump 27' smaller than it on the 1st bump 27, as shown in drawing 2 , and she is doing the configuration of the letter of a salient which became two steps (only henceforth a bump 27).
[0030] Drawing 3 (a) - (f) shows the outline of the method of using a capillary tube 1 and forming a two-step bump on the electrode pad 13 formed after the IC chip 6, by the ball bonding method in the 1st example of this invention.
[0031] it is shown in drawing 3 (a) -- as -- wire derivation of a capillary tube 1 -- it lets the metal wire 4 of 25 micrometerphi pass to a hole 2 And the ball 5 which has an about 2 to 3 times as many diameter as the path of the metal wire 4 is formed at the nose of cam of the metal wire 4 by giving heat energy.
[0032] Next, the ball 5 formed at the nose of cam of the metal wire 4 is made to contact the electrode pad 13 of the IC chip 6 by dropping a capillary tube 1, as shown in drawing 3 (b). By giving the method and supersonic oscillation of thermocompression bonding, the electrode pad 13 is made to fix a ball 5, and a two-step bump's pars basilaris ossis occipitalis 9 is formed.
[0033] and it is shown in drawing 3 (c) -- as -- a two-step bump's pars basilaris ossis occipitalis 9, and wire derivation of a capillary tube 1 -- while it has been in the state with which the metal wire 4 which the hole 2 let pass was connected, a capillary tube 1 is moved in the shape of a loop to the IC chip 6 After going up first at right angles to a two-step bump's pars-basilaris-ossis-occipitalis 9 upper part, a capillary tube 1 moves so that a loop-like orbit may be drawn.
[0034] As shown in drawing 3 (d), when a capillary tube 1 exercises in the shape of a loop to the IC chip 6, on a pars basilaris ossis occipitalis 9, the metal wire 4 is formed the shape of a ring, and inverted-L-shaped.

[0035] Then, a capillary tube 1 is moved so that the edge portion 12 of a capillary tube 1 may be located in the periphery of a two-step bump's pars basilaris ossis occipitalis 9, and the edge portion 12 cuts the metal wire 4, descending perpendicularly. A capillary tube 1 continues descent as it is, and carries out the press plastic surgery of the two-step bump according to the soffit side 15 for a lobe 3 established in the periphery section of a capillary tube 1. At this time, a capillary tube 1 descends until the face 11 contacts the electrode pad 13 (refer to drawing 3 (e)).
[0036] Moreover, as shown in drawing 3 (f), when it sees from a transverse plane, the soffit side 15 of a capillary may be made as the curve side is formed, and the direction in which a curve side is formed is not asked.
[0037] next, a part of semiconductor unit to which drawing 4 mounted the semiconductor device in the 1st example of this invention on the circuit board -- it is a cross section As shown in drawing 4 , the electroconductive glue 25 as a junction layer is applied to the curve side 24 of the point of the bump of the semiconductor device (IC substrate) 6 obtained at the above-mentioned process by the replica method or print processes. In this example, by using the bump of the letter of a two-step salient, it can prevent the electroconductive glue 25 more than an initial complement adhering to a bump point, and the electroconductive glue 25 of optimum dose can be applied. However, if the bump has the curve side 24 in the point, especially the configuration will not be restricted.
[0038] By this, thickness of a junction layer is made with the thinnest uniform thing, and connection resistance of a connection is low and can realize reliable electrical installation and reliable adhesion.
[0039] (Example 2) Drawing 5 (a) - (c) shows the outline of the method of forming the concave-like curve side 24 in a bump's point formed on the electrode pad 13 on the IC chip 6 in the 2nd example of this invention at a point using a ** implement with the convex type-like curve side 41.
[0040] Drawing 5 (a) is the two-step bump formed on the electrode pad 13 on the IC chip 6. The concave-like curve side 24 is formed in a bump's point by pressing this bump's point using a ** implement with the convex type-like curve side 41. At this time, as shown in drawing 5 (b) and (c), the direction in which a curve side is formed is not asked.
[0041] Even if it uses this formation method, the semiconductor unit shown in drawing 4 is obtained.
(Example 3) the cross section (a) of the semiconductor device which has a concave-like curve side in a bump's point in the 3rd example of this invention when drawing 6 uses a solder plating bump, and a part of semiconductor unit which mounted the semiconductor device on the circuit board -- it is a cross section (b)

[0042] (Example 4) the cross section (a) of the semiconductor device which has a concave-like curve side in a bump's point in the 4th example of this invention when drawing 7 uses the bump of the letter of an one-step salient, and a part of semiconductor unit which mounted the semiconductor device on the circuit board -- it is a cross section (b)
[0043] (Example 5) a part of semiconductor unit which carried out the boundary of the anisotropy electric conduction material, and mounted the semiconductor device with which drawing 8 was obtained in the examples 1 and 2 on the circuit board -- it is a cross section
[0044] (Example 6) a part of semiconductor unit which drawing 9 carried out the boundary of the anisotropy electric conduction material which had the thickness more than the gap of a semiconductor device and the circuit board for the semiconductor device obtained in the examples 1 and 2, and was mounted on the circuit board -- it is a cross section
[0045]
[Effect of the Invention] Since a curve side can be easily formed in a bump's point formed using the usual ball bonding method, usual plating, etc. according to this invention, without being restricted to a special bump's structure and manufacture method as explained above, versatility is very high on practical use.
[0046] Furthermore, by this invention, by forming a curve side in the point of the bump of a semiconductor device, the junction distance between the interfaces of a bump and the terminal electrode on the circuit board can be shortened, and electric conductivity can be raised. By this, a bond strength is increased, it is further more certain and reliable electrical installation can be obtained.

[Translation done.]

* NOTICES *

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] The capillary tube for the ball bondings for forming a bump on the electrode pad of a semiconductor device characterized by providing the following. the press to which the aforementioned capillary tube presses the point of the shape of a ball of a metal wire to an electrode pad, and the aforementioned ball-like point is made to stick to the aforementioned electrode pad by pressure -- a member the derivation which supplies the aforementioned metal wire prepared in the aforementioned press member -- a hole leveling for establishing the field which curved in the shape of a concave to a bump's point formed on the aforementioned electrode pad -- a member

[Claim 2] It is a capillary tube for the wirebonding equipments according to claim 1 with which the press member includes the soffit side (1st soffit side) of a capillary tube, a leveling member has the 2nd soffit side which presses a bump, and the soffit side of the above 2nd has the convex curve side.

[Claim 3] The bump who is a bump for connecting electrically the terminal electrode of the front face of the circuit board, and the electrode pad of the semiconductor device mounted in the state of a face down on the front face of the aforementioned circuit board, and has the field which was formed on the electrode pad of the aforementioned semiconductor device, and which curved in the shape of a concave to the point.

[Claim 4] How to form the bump for connecting electrically the terminal electrode of the front face of the circuit board, and the electrode pad of the semiconductor device mounted in the state of a face down on the front face of the aforementioned circuit board using wirebonding equipment characterized by providing the following. The process a which forms the aforementioned bump on the electrode pad of the aforementioned semiconductor device. The process b which forms a curve side in the aforementioned bump's point in the shape of a concave at the same time it excises a metal wire.

[Claim 5] Process b is the formation method of the bump who has the curve side according to claim 4 characterized by including the process which levels the aforementioned bump in order to arrange a bump's point configuration.

[Claim 6] A bump is the formation method of the bump who has the curve side according to claim 4 characterized by being formed from the alloy containing Au, Cu, aluminum, solder, or these either.

[Claim 7] Process a is the formation method of the bump who has the curve side according to claim 4 characterized by forming a bump on an electrode pad by the ball bonding method.

[Claim 8] How to form the bump for connecting electrically the terminal electrode of the front face of the circuit board characterized by providing the following, and the electrode pad of the semiconductor device mounted in the state of a face down on the front face of the aforementioned circuit board. The process which forms the aforementioned bump on the electrode pad of the aforementioned semiconductor device. The curve side characterized by the bird clapper from the process formed using the ** implement which has a convex type-like curve side for a concave-like curve side in the aforementioned bump's point.

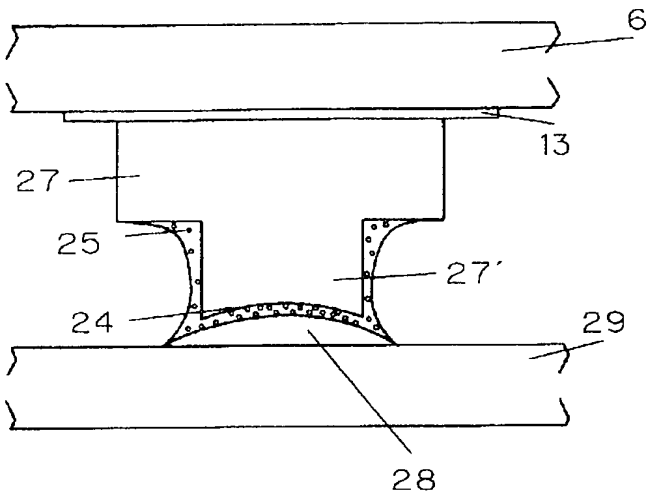
[Claim 9] A bump is the formation method of the bump who has the curve side according to claim 8 characterized by being formed on an electrode pad by plating, the wirebonding method, etc.

[Claim 10] The circuit board which has a terminal electrode on a front face. The semiconductor device mounted in the state of the face down on the front face of the aforementioned circuit board. It is the semiconductor unit equipped with the above, and the aforementioned semiconductor device is characterized by having a bump for connecting electrically an electrode pad, the aforementioned electrode pad, and the aforementioned terminal electrode, forming a curve side in the aforementioned bump's point, and forming the junction layer between the aforementioned bump's point, and the aforementioned terminal

electrode.
[Claim 11] A junction layer is a semiconductor unit according to claim 10 characterized by being formed from an electroconductive glue.
[Claim 12] A junction layer is a semiconductor unit according to claim 10 characterized by being formed from anisotropy electric conduction material.

[Translation done.]

Drawing selection [Representative drawing]



[Translation done.]